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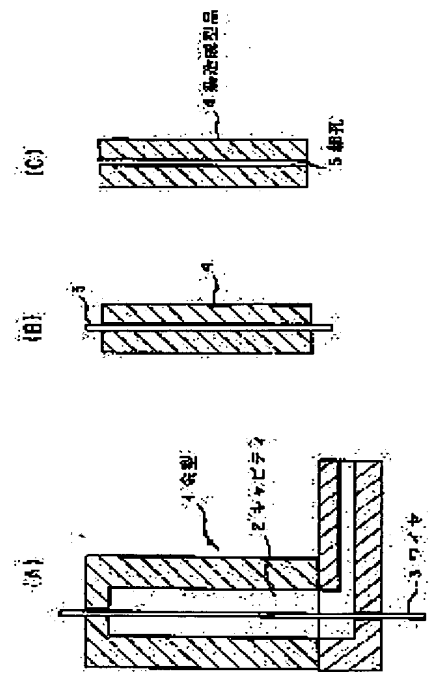
(71)Applicant : YKK CORP
(72)Inventor : NAGAHAMA HIDENOBU
YAMAGUCHI MASASHI
SATO MASANORI

(54) METHOD AD APPARATUS FOR MANUFACTURING CASTING PRODUCT HAVING SMALL MOLE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method and an apparatus for manufacturing a casting product having a small hole at a low cost, with a high productivity and in a short time by reducing troubles that may be caused in the difficulty of a draw of a linear core material after casting or caused in its durability.
SOLUTION: A casting product 4 having a small hole 5 with a wire cross section shape is manufactured by using a surface coated or surface treated wire as the due wire when molten metal is casted into a cavity 2 of a mold 1 to which a wire 3 (linear core material) with a desired cross section shape is preset, and by enabling only the wire to be drawn as its membrane formed by surface coating or surface treatment is partially or totally exfoliated by the draw. When the wire is drawn out of a casting material after casting, the wire can be drawn as well, by employing a material of high elastic limit to the wire, out of the inside of the casting material as a diameter of the wire becomes small by its elastic deformation in the direction of the draw.



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CLAIMS

[Claim(s)]

[Claim 1]a line with desired sectional shape -- a core -- casting a molten metal in a cavity of a metallic mold with which a member was set -- the above-mentioned line -- a core -- in a method of manufacturing a casting mold article in which a small hole with sectional shape of a member was formed, the above-mentioned line -- a core -- a line to which a member performed surface coating or a surface treatment -- a core -- it is a member -- after casting -- a line from a casting material -- a core -- drawing out a member -- the above-mentioned line -- a core -- a manufacturing method of a casting mold article which has a small hole forming a small hole with sectional shape of a member.

[Claim 2]after casting -- a line from a casting material -- a core -- a part or all the portions of a coat formed of the above-mentioned surface coating or a surface treatment when drawing out a member -- a line -- a core -- exfoliating from a member surface -- a line -- a core -- a method according to claim 1, wherein a member enables it to draw out from an inside of a casting material.

[Claim 3]said line -- a core -- a coat formed of surface coating or a surface treatment of a member -- a line -- a core -- a method of being an oxide film, a nitride, or a carbonization film containing an element which constitutes a member according to claim 1 or 2.

[Claim 4]said line -- a core -- a method according to any one of claims 1 to 3, wherein a member consists of a Ti system alloy.

[Claim 5]said line -- a core -- a method according to any one of claims 1 to 4 that thickness of a coat formed of surface coating or a surface treatment of a member is characterized by being 0.5-100 micrometers.

[Claim 6]a line with desired sectional shape -- a core -- casting a molten metal in a cavity of a metallic mold with which a member was set -- the above-mentioned line -- a core -- in a method of manufacturing a casting mold article in which a small hole with sectional shape of a member was formed, after casting -- a line from a casting material -- a core -- the time of keeping lengthening a member -- a line -- a core -- a member carries out elastic deformation in the direction of drawing -- a line -- a core -- a path of a member becomes thin -- a line -- a core -- a manufacturing method of a casting mold article which has a small hole, wherein a member enables it to draw out from an inside of a casting material.

[Claim 7]said line -- a core -- a method according to any one of claims 1 to 6, wherein a member consists of a nickel-Ti system superelastic alloy.

[Claim 8]said line -- a core -- a method according to any one of claims 1 to 7, wherein thickness of a member is phi0.025-phi1mm.

[Claim 9]said line -- a core -- the time of setting a member in a metallic mold -- a line -- a core -- a method of adding tensile load below 1960-N[/mm] ^{2} to a longitudinal direction of a member, and casting a molten metal in a cavity of a metallic mold in this state according to any one of claims 1 to 8.

[Claim 10]A method according to any one of claims 1 to 9, wherein said casting material is an alloy which contains an amorphous phase of not less than 50% of a volume rate at least.

[Claim 11]A method according to claim 10, wherein said amorphous alloy has the presentation shown by any one of the following general formula (1) - (6) in it being an amorphous alloy substantially.

general formula $^{1}{}_{a}$[(1):M] $M^2{}_bLn_cM^3{}_dM^4{}_eM^5{}_f$ -- however, One sort or two sorts of elements chosen from Zr and Hf and M^2 M^1 nickel, At least one sort of elements chosen from a group which consists of Cu, Fe, Co, Mn, Nb, Ti, V, Cr, Zn, aluminum, and Ga, At least one sort of elements chosen from a group which Ln becomes from Y, La, Ce, Nd, Sm, Gd, Tb, Dy, Ho, Yb, and Mm (misch metal which is an aggregate of a rare earth element), At least one sort of elements chosen from a group which M^3 becomes from Be, B, C, N, and O, At least one sort of elements chosen from a group which M^4 becomes from Ta, W, and Mo, at least one sort of elements chosen from a group which M^5 becomes from Au, Pt, Pd, and Ag, a, b, c, d, e, and f are atomic %, respectively, It is 25<=a<=85, 15<=b<=75, 0<=c<=30, 0<=d<=30, 0<=e<=15, and 0<=f<=15.

General formula (2):aluminum$_{100-g-h-i}$Ln$_g$M$^6{}_h$M$^3{}_i$ -- however, At least one sort of elements chosen from a group which Ln becomes from Y, La, Ce, Nd, Sm, Gd, Tb, Dy, Ho, Yb, and Mm, M^6 Ti, V, Cr, Mn, Fe, Co, nickel, Cu, Zr, At least one sort of elements chosen from a group which consists of Be, B, C, N, and O, g, h, and i are atomic %, respectively, and at least one sort of elements chosen from a group which consists of Nb, Mo, Hf, Ta, and W, and M^3 are 30<=g<=90, 0< h<=55, and 0<=i<=10.

General-formula (3): $Mg_{100-p}M^7_p$ however at least one sort of elements chosen from a group which M^7 becomes from Cu, nickel, Sn, and Zn, and p are 5<=p<=60 in atomic %.
General formula (4):$Mg_{100-q-r}M^7_qM^8_r$ -- however, At least one sort of elements chosen from a group which consists of Cu, nickel, Sn, and Zn, at least one sort of elements chosen from a group which M^8 becomes from aluminum, Si, and Ca, and q and r are atomic %, respectively, and M^7 is 1<=q<=35 and 1<=r<=25.
General formula (5):$Mg_{100-q-s}M^7_qM^9_s$ -- however, At least one sort of elements chosen from a group which consists of Cu, nickel, Sn, and Zn, at least one sort of elements chosen from a group which M^9 becomes from Y, La, Ce, Nd, Sm, and Mm, and q and s are atomic %, respectively, and M^7 is 1<=q<=35 and 3<=s<=25.
General formula (6):$Mg_{100-q-r-s}M^7_qM^8_rM^9_s$ -- however, At least one sort of elements chosen from a group which M^7 becomes from Cu, nickel, Sn, and Zn, At least one sort of elements chosen from a group which consists of aluminum, Si, and Ca, at least one sort of elements chosen from a group which M^9 becomes from Y, La, Ce, Nd, Sm, and Mm, q, r, and s are atomic %, respectively, and M^8 is 1<=q<=35, 1<=r<=25, and 3<=s<=25.
[Claim 12]A method according to any one of claims 1 to 11, wherein said casting mold article is an optical connector part which inserts in or holds an optical fiber.
[Claim 13]A manufacturing installation of a casting mold article characterized by comprising the following which has a small hole.
A metallic mold which has a cavity which regulates a product outside.
A movable cylindrical guide member allocated in a cavity of this metallic mold enabling free projection and retreat.
a line set in a metallic mold cavity through a feed hole of this movable cylindrical guide member -- a core -- a member.
a line -- a core -- a means to add arbitrary tensile loads below 1960-N[/mm] ^{2} to a longitudinal direction of a member.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention a small hole about the manufacturing method and device of a casting mold article which it has in more detail, It is related with small hole forming technique, such as a cast which has a small hole manufactured by metal mold casting, especially metal mold casting of an amorphous alloy (metallic glass), especially optical connector parts (a ferrule, a capillary, etc.).
[0002]
[Description of the Prior Art]It has a small hole and the ferrule or capillary of an optical connector is mentioned as a typical thing of the cast in which close dimensional accuracy is moreover demanded. If it explains hereafter, referring to an accompanying drawing, drawing 6 shows the ferrule 10 of the integral type [in an optical connector / the capillary part 11 and the flange 12]. Namely, the capillary part 11 in which the breakthrough 13 of the byway for the ferrule 10 to insert the optical fiber 17 (or optical fiber wire) was formed along the axis line, It consists of the flange 12 in which the breakthrough 14 of the major diameter for plastic coated fiber 16 (that by which the cover was laminated on the periphery of the optical fiber) insertion was formed along the axis line, and the breakthrough 13 of a byway and the breakthrough 14 of the major diameter are connected via the taper diameter 15. Connection of the optical fibers 17 and 17 of a couple inserts each ferrules 10 and 10 by which they were inserted and joined from the both ends of the split sleeve 18, It is carried out by comparing the end of the ferrule 10 and ten comrades, and after the axis of the optical fibers 17 and 17 has aligned by this, a tip part compares and is connected. On the other hand, as for drawing 7, the capillary 11a and the flange 12a of the optical connector show the ferrule 10a for optical connectors of the different body.
[0003]The aperture of the fine pores which let an optical fiber pass has phi0.126mm and 10-mm-deep fine pores in the capillary (ferrule) called SC type by a type, for example although it is various. Conventionally, the ferrule is produced with ceramics, such as zirconia. Fine-pores shaping of the ferrule made from ceramics carries out injection molding of the ferrule which has smaller fine pores beforehand, and is finish-machined by the regular size by wire-wrapping processing after calcination. The ferrule made from ceramics is produced through many processes, such as outside diameter working and polish, besides inside diameter processing. Therefore, a manufacturing process is huge and obliged to increase of cost.
[0004]As a method of solving the above problems, these people already with the combination of the amorphous alloy in which the art which used the conventional metal-mold-casting method as the base, and a glass transition region are shown. Even if it is a cast which has fine pores like the ferrule for optical connectors, and a complicated-shaped cast, patent application of the method that the amorphous alloy cast with which it is satisfied of predetermined shape, dimensional accuracy, and surface quality can be manufactured with sufficient mass production nature in a single process is developed and carried out (JP,10-186176,A). The manufacturing method of the amorphous alloy cast which has the small hole currently indicated here, The molten metal of the material which may produce an amorphous alloy is fundamentally filled up with and cast at high speed in the metallic mold cavity which set the core pin, and a small hole is fabricated by drawing out a core pin from a casting material after that.
[0005]
[Problem(s) to be Solved by the Invention]Usually, in order to obtain the casting mold article which has a small hole, the core pin which applied the release agent uniformly must be used. However, since a release agent evaporates at a stretch when a molten metal touches a core pin, since the release agent is used, air bubbles and a defect will remain into a casting mold article. Since the direction in which a release agent evaporates was not always able to control uniformly, it had the problem that dimensional accuracy of a small hole portion could not be made highly precise. Since a crevice will almost be lost between the core pin for forming a small hole, and a casting material if it casts by making higher injection pressure at the time of casting in order to obtain a highly precise casting mold article moreover, The problem of a core pin stopping falling out and the problem of damaging a pin surface or making it damage arise. And this core pin is produced by cemented carbide, and since it is expensive, there is a problem that repeated use becomes impossible and a manufacturing cost will increase as a result by the crack of this pin and breakage. Such a problem is not a problem peculiar to the ferrule for optical connectors, or a capillary but a problem common to the case of metal mold casting of the metal cast which has a small hole.
[0006]therefore, the line used for casting of the casting mold article in which the fundamental purpose of this invention has a small hole — a core — said problem of versatility which was carried out resulting from the difficulty and endurance of drawing after casting of a member being reduced, and it being low cost with productivity sufficient

for a short time, and, It is in providing the method and device which can manufacture the casting mold article which has a small hole. Furthermore, even if the more specific purpose of this invention is an amorphous alloy cast which has a slit, It is going to provide the cheap amorphous alloy cast which has the small hole which provided and had again the method and device which can carry out a fabricating operation by predetermined shape, close dimensional accuracy, and surface quality at the easy process, and was excellent in endurance, intensity, shock resistance, etc. especially the ferrule for optical connectors, or a capillary.

[0007]

[Means for Solving the Problem]In order to attain said purpose, according to the first side of this invention, it is provided by manufacturing method of a casting mold article which has a small hole, and the first mode, a line of desired sectional shape -- a core, when a member casts a molten metal in a cavity of a metallic mold set beforehand, the above-mentioned line -- a core -- a line to which a member performed surface coating or a surface treatment -- a core -- it is a member -- after casting -- a line from a casting material -- a core -- drawing out a member -- the above-mentioned line -- a core -- it is characterized by forming a small hole with sectional shape of a member. in this case -- suitable -- after casting -- a line from a casting material -- a core -- a part or all the portions of a coat formed of the above-mentioned surface coating or a surface treatment when drawing out a member -- a line -- a core -- exfoliating from a member surface -- a line -- a core -- a member enables it to draw out from an inside of a casting material

[0008]the second mode of a method of this invention -- a line of desired sectional shape -- a core -- a member casts a molten metal in a cavity of a metallic mold set beforehand -- the above-mentioned line -- a core -- in a method of manufacturing a casting mold article in which a small hole of sectional shape of a member was formed, after casting -- the above-mentioned line from a casting material -- a core -- the time of drawing out a member -- a line -- a core -- a member carries out elastic deformation in the direction of drawing -- a line -- a core -- a path of a member becomes thin -- a line -- a core -- it is characterized by a member enabling it to draw out from an inside of a casting material.

[0009]A metallic mold which has a cavity which regulates a product outside according to the second side of this invention, A movable cylindrical guide member allocated in a cavity of this metallic mold enabling free projection and retreat, a line set in a metallic mold cavity through a feed hole of this movable cylindrical guide member -- a core -- a member and a line -- a core -- a manufacturing installation of a casting mold article provided with a means to add arbitrary tensile loads below 1960-N[/mm] ^{2} to a longitudinal direction of a member which has a small hole is provided. With above methods and devices, a ferrule for a casting mold article which has a small hole especially an amorphous alloy cast, and also optical connectors, or a capillary can be manufactured with sufficient productivity.

[0010]

[Embodiment of the Invention]manufacture of the casting mold article which has a small hole by this invention -- a line -- a core -- as opposed to said problem which originates in the difficulty and endurance of drawing after casting of a member and which was carried out -- a line -- a core -- the drawing nature of a member is improved. the line after this casting -- a core -- methods of improving the drawing nature of a member include the following methods. in addition -- in the following -- a line -- a core -- a member is explained as a wire.

[0011](1) surface coating and the shape of a surface treatment wire normal -- a core -- they are the method of coating the coat which exfoliates easily in a wire surface, or a method of using the wire to which the surface coat has adhered on manufacture so that it may be easy to release from mold the wire which is a member from a casting material. A small hole with the sectional shape of the wire can form in a casting mold article by a surface coat's exfoliating selectively or on the whole from a wire, and being able to draw out only a wire by this, since the surface coat of a wire has stuck with the casting material when drawing out a wire from a casting material. The surface coat of the above-mentioned wire forms materials, such as an oxide, a nitride, and carbide, by suitable methods, such as a method made [a wire surface] to carry out ** arrival with physical gaseous phase vacuum deposition (PVD), chemical gaseous phase vacuum deposition (CVD), etc., electroplating, such as metal, electroless deposition, hot dipping, for example. When a wire is an activity metallic material, even if the surface coat of the above-mentioned wire does not perform special processing in a manufacturing process, it can also use that in which coats which contain a wire composing element as a scale, such as an oxide, a nitride, and carbide, remain as it is. As the thickness of film, about about 0.5-100 micrometers is preferred from points, such as the detachability of a coat, and the drawing nature of a wire. In the case of this method, various materials can be used as a wire material, but the Ti system alloy which was excellent in heat resistance etc. also in it is preferred.

[0012](2) It is the method of using the high wire of an elastic limit as an elastic wire and a superelasticity wire method wire (line a core member). Since a wire becomes thin to the small hole of a casting material and the clearance between a wire and a casting material is secured by this, when a wire carries out elastic deformation to the direction of drawing when drawing out a wire from a casting material, A wire can be drawn out and a small hole with the sectional shape of the wire can form in a casting mold article. As the above-mentioned wire, the charge of spring material, the charge of high tension steel materials, hyperelastic materials (nickel-Ti system hyperelastic material etc.), etc. can be used, for example. The above mentioned method of of (1) and (2) is employable in combination.

[0013]Furthermore, according to this invention, for protection of a set into the metallic mold cavity of a wire (line a core member) and the wire at the time of casting, The metallic mold provided with the movable cylindrical guide member in which projection and retreat are free in the cavity is used, receiving the longitudinal direction of a wire, when setting a wire in a metallic mold cavity through the feed hole with this cylindrical guide member -- arbitrary

tensile loads -- the tensile load below about 1960-N[/mm] ^{2} is applied preferably. Since it is protected since the wire of the portion covered with it by using such a cylindrical guide member does not contact a molten metal, and a touch area with a casting material becomes small, the rate which a wire gets damaged in the case of drawing, or is damaged decreases. Since tensile load is moreover applied to the wire, when a molten metal flows in in a cavity, a wire does not bend carelessly and a casting mold article with high accuracy of a small hole can be produced. This method is employable combining the above mentioned all directions method. Although it is arbitrarily changeable as thickness of a wire according to the desired diameter of a small hole, in manufacture of the parts for optical connectors, generally, it is set up within the limits of phi0.025-1mm.

[0014]If it is the material used by general casting as a material of a casting material used by the method of this invention, it is altogether usable and is not limited to a specific material, but the substantially amorphous alloy which contains the amorphous phase of not less than 50% of a volume rate at least preferably can use it conveniently. The amorphous alloy which has still more preferably the presentation shown by any one of the following general formula (1) - (6) can be used conveniently.

general formula $^1{}_a$[(1):M] $M^2{}_bLn_cM^3{}_dM^4{}_eM^5{}_f$ -- however, One sort or two sorts of elements chosen from Zr and Hf and M^2 M^1 nickel, At least one sort of elements chosen from the group which consists of Cu, Fe, Co, Mn, Nb, Ti, V, Cr, Zn, aluminum, and Ga, At least one sort of elements chosen from the group which Ln becomes from Y, La, Ce, Nd, Sm, Gd, Tb, Dy, Ho, Yb, and Mm (misch metal which is an aggregate of a rare earth element), At least one sort of elements chosen from the group which M^3 becomes from Be, B, C, N, and O, At least one sort of elements chosen from the group which M^4 becomes from Ta, W, and Mo, at least one sort of elements chosen from the group which M^5 becomes from Au, Pt, Pd, and Ag, a, b, c, d, e, and f are atomic %, respectively, It is 25<=a<=85, 15<=b<=75, 0<=c<=30, 0<=d<=30, 0<=e<=15, and 0<=f<=15.

[0015]The above-mentioned amorphous alloy contains a following general formula (1-a) and an amorphous alloy - (1-p).

General formula (1-a): Since M^2 element coexists with Zr or Hf, the amorphous alloy of $M^1{}_aM^2{}_b$ ** has large mixed enthalpies negative, and its amorphous organization potency is good.

General formula (1-b): Like the amorphous alloy of $M^1{}_aM^2{}_bLn_c$ **, amorphous thermal stability improves by adding a rare earth element into the alloy of the above-mentioned general formula (1-a).

[0016]general formula (1-c): -- $M^1{}_aM^2{}_bM^3{}_d$ general formula (1-d): -- $M^1{}_aM^2{}_bLn_cM^3{}_d$ -- like the amorphous alloy of these, By filling up the crevice in amorphous structure with element M^3 with a small atomic radius (Be, B, C, N, O), the structure is stable and amorphous organization potency improves.

[0017]A general formula. (1-e):. $M^1{}_aM^2{}_bM^4{}_e$ general formula (1-f): -- $M^1{}_aM^2{}_bLn_cM^4{}_e$ general formula (1-g): -- an $M^1{}_aM^2{}_bM^3{}_dM^4{}_e$ general formula. (1-h): $M^1{}_aM^2{}_bLn_cM^3{}_dM^4{}_e$ -- like the amorphous alloy of these, when refractory metal M^4 (Ta, W, Mo) is added, heat resistance and corrosion resistance improve, without affecting amorphous organization potency.

[0018]A general formula. (1-i) :. $M^1{}_aM^2{}_bM^5{}_f$ general formula (1-j): -- $M^1{}_aM^2{}_bLn_cM^5{}_f$ general formula (1-k): -- an $M^1{}_aM^2{}_bM^3{}_dM^5{}_f$ general formula. (1-l):. $M^1{}_aM^2{}_bLn_cM^3{}_dM^5{}_f$ general formula (1-m): -- $M^1{}_aM^2{}_bM^4{}_eM^5{}_f$ general formula (1-n): -- $M^1{}_aM^2{}_bLn_cM$. A $^4{}_eM^5{}_f$ general formula. (1-o):. $M^1{}_aM^2{}_bM^3{}_dM^4{}_eM^5{}_f$ general formula (1-p): -- $M^1{}_aM^2{}_bLn_cM^3{}_dM^4{}_eM^5{}_f$ -- as for these, precious-metals M^5. In the case of the amorphous alloy having contained (Au, Pt, Pd, Ag), it does not become weak even if crystallization occurs.

[0019]

General formula (2):aluminum$_{100-g-h-i}Ln_gM^6{}_hM^3{}_i$ -- however, At least one sort of elements chosen from the group which Ln becomes from Y, La, Ce, Nd, Sm, Gd, Tb, Dy, Ho, Yb, and Mm, M^6 Ti, V, Cr, Mn, Fe, Co, nickel, Cu, Zr, At least one sort of elements chosen from the group which consists of Be, B, C, N, and O, g, h, and i are atomic %, respectively, and at least one sort of elements chosen from the group which consists of Nb, Mo, Hf, Ta, and W, and M^3 are 30<=g<=90, 0< h<=55, and 0<=i<=10.

[0020]The above-mentioned amorphous alloy contains the amorphous alloy of a following general formula (2-a) and (2-b).

General formula (2-a): The amorphous alloy of aluminum$_{100-g-h}Ln_gM^6{}_h$ ** has large mixed enthalpies negative, and its amorphous organization potency is good.

General formula (2-b) : In the amorphous alloy of aluminum$_{100-g-h-i}Ln_gM^6{}_hM^3{}_i$ **, By filling up the crevice in amorphous structure with element M^3 with a small atomic radius (Be, B, C, N, O), the structure is stable and amorphous organization potency improves.

[0021]General-formula (3): $Mg_{100-p}M^7{}_p$ however at least one sort of elements chosen from the group which M^7 becomes from Cu, nickel, Sn, and Zn, and p are 5<=p<=60 in atomic %. This amorphous alloy has large mixed enthalpies negative, and its amorphous organization potency is good.

[0022]General formula (4):$Mg_{100-q-r}M^7{}_qM^8{}_r$ -- however, At least one sort of elements chosen from the group which consists of Cu, nickel, Sn, and Zn, at least one sort of elements chosen from the group which M^8 becomes from aluminum, Si, and Ca, and q and r are atomic %, respectively, and M^7 is 1<=q<=35 and 1<=r<=25. By filling up the crevice in amorphous structure with element M^8 with a small atomic radius (aluminum, Si, Ca) in the alloy of said general formula (3) like this amorphous alloy, that structure is stable and amorphous organization potency improves.
[0023]General formula (5):$Mg_{100-q-s}M^7{}_qM^9{}_s$ general formula (6):$Mg_{100-q-r-s}M^7{}_qM^8{}_rM^9{}_s$ -- however, At least one sort of elements chosen from the group which M^7 becomes from Cu, nickel, Sn, and Zn, At least one sort of elements chosen from the group which consists of aluminum, Si, and Ca, at least one sort of elements chosen from the group which M^9 becomes from Y, La, Ce, Nd, Sm, and Mm, q, r, and s are atomic %, respectively, and M^8 is 1<=q<=35, 1<=r<=25, and 3<=s<=25. Like these amorphous alloys, amorphous thermal stability improves by adding a rare earth element into said general formula (3) and the alloy of (4).
[0024]Also in the above mentioned amorphous alloy, the Zr-TM-aluminum system and Hf-TM-aluminum system (TM: transition metal) amorphous alloy of glass transition temperature (Tg) and crystallization temperature (Tx) in which a temperature gradient is very large, It is high intensity and high corrosion resistance, and especially a Zr-TM-aluminum system amorphous alloy has supercooled liquid zone (glass transition region) deltaTx=Tx-Tg very as large as 60K or more, and more than 30K shows the processability in which even the low stress of several 10 or less MPa is very good by viscous flow in this temperature range. It has the feature which it is dramatically stable and is easy to manufacture -- an amorphous bulk material is obtained also by the casting process whose cooling rate is about several 10K/s. While these alloys can do amorphous materials also by the fabricating operation by the viscous flow using a glass transition region even if they are based on metal mold casting from a molten metal and, they reproduce die shape and a size very faithfully.
[0025]Although these Zr-TM-aluminum systems and Hf-TM-aluminum system amorphous alloy which are used for this invention change also with alloy composition and measuring methods, they have the range of very big deltaTx. For example, deltaTx of a $Zr_{60}aluminum_{15}Co_{2.5}nickel_{7.5}Cu_{15}$ alloy (Tg:652K, Tx:768K) is very as large as 116K. Even if oxidation resistance is also very good and it heats it to the elevated temperature to Tg in the air, it hardly oxidizes. From a room temperature to near Tg, hardness amounts to 460 (DPN) in Vickers hardness (Hv), tensile strength reaches 1,600MPa, and flexural strength reaches 3,000MPa. The coefficient of thermal expansion alpha is as small as $1x10^{-5}$/K from a room temperature to near Tg, and, as for Young's modulus, the elasticity limit at the time of 91GPa and compression exceeds 4 to 5%. Toughness is also still higher and a Charpy impact value shows 60 - 70 kJ/m^2. Thus, if it is heated to a glass transition region while the characteristic of high intensity is shown dramatically, flow stress will decline to about 10 MPa. For this reason, processing is very easy and it is the feature of this alloy that it can fabricate by low stress on complicated-shaped a minute part and high precision parts. And steps to which a slip band appears in the surface like [the characteristic as what is called glass (amorphous) to the processing (modification) surface has very high smooth nature, and / when changing a crystal alloy] have the feature which is not generated substantially.
[0026]Generally, if an amorphous alloy is heated to a glass transition region, crystallization will start by prolonged maintenance, but. The alloy with large deltaTx has a stable amorphous phase like this alloy, and if the temperature in deltaTx is chosen suitably, till about 2 hours, it is not generated by the crystal and does not need to be anxious about crystallization in the usual fabricating operation. This alloy demonstrates this characteristic without how also in the coagulation from a molten metal. Although rapid cooling is generally needed for manufacture of an amorphous alloy, this alloy can obtain the bulk material which consists of amorphous single phase easily from a molten metal by cooling of about 10 K/s of cooling rates. It is very smooth too and the coagulation surface has the transfer nature which reproduces faithfully even the polishing flaw of the micron order on the surface of a metallic mold. Therefore, if it has the surface quality by which the metallic mold surface will fulfill the demand characteristics of a cast if this alloy is applied as a charge of a casting material, also in a casting material, the surface characteristic of a metallic mold can be reproduced as it is, and the process of size adjustment and surface roughness adjustment can be skipped or shortened also in the conventional metal-mold-casting method.
[0027]As mentioned above, comparatively low hardness, high tensile strength and high flexural strength, comparatively low Young's modulus, The feature having a high elasticity limit, high shock resistance, high abrasion resistance, surface smooth nature, highly precise casting, or processability is suitable as a material of the cast of various fields, such as a ferrule, a sleeve, etc. of an optical connector. Since it has the outstanding transfer nature which an amorphous alloy has highly precise fluidity and processability, and can reproduce the cavity form of a metallic mold faithfully, By producing a metallic mold appropriately, the cast with which it is satisfied of predetermined shape, dimensional accuracy, and surface quality by a metal-mold-casting method can be manufactured with sufficient mass production nature in a single process. However, it is because there is almost no crevice between a die cavity surface and a casting material to have the outstanding transfer nature which can reproduce the cavity form of a metallic mold faithfully. Therefore, when picking out a cast from a metallic mold, as described above, since the core pin which forms a small hole is thin and its intensity is not enough, the problem of damaging this pin or damaging has produced it. Since this invention is what solves such a problem, it can be applied very effective in manufacture of the amorphous alloy cast which has especially a small hole.
[0028]As a metallic material used for manufacture of the casting mold article of this invention, alloys for die-castings, such as Mg group alloy, Zn group alloy, aluminum group alloy, a Fe group alloy besides an amorphous alloy

which was described above, Cu group alloy, and a titanium alloy, can be used conveniently. Such an alloy for die-castings is an alloy used by the usual casting process, Compared with ceramics, an amorphous alloy, etc. which are used for the conventional member for optical connectors, it is cheap, and the member for optical connectors can be easily manufactured by pressing fit and fabricating this alloy in a metallic mold with a die casting machine.
[0029]For example, as an aluminum group alloy, the aluminum alloy for die-castings of aluminum-Si systems, such as ADC1 with a JIS sign, ADC5, and ADC12, an aluminum-Mg system, an aluminum-Si-Cu system, or an aluminum-Si-Mg system can be used conveniently, and especially ADC12 is useful. Similarly, as a Mg group alloy, MDC1A, MDC2A, MDC3A, etc. can use conveniently the Magnesium alloy for die-castings of a Mg-aluminum system or a Mg-aluminum-Zn system, for example, and especially MDC1A is useful. As a Zn group alloy, the zinc alloy for die-castings of Zn-aluminum systems, such as AG40A, AG41A, and a high Mn alloy, a Zn-aluminum-Cu system, a Zn-aluminum-Cu-Mg system, or a Zn-Mn-Cu system can be used conveniently, for example, and especially the high Mn alloy is useful. In a Fe group alloy, there are gray iron, austenitic cast iron, stainless cast steel, etc., for example, and especially stainless cast steel is useful. In Cu group alloy, there are brass, bronze, aluminum bronze, etc., for example, and especially aluminum bronze is useful. In a titanium alloy, there are alpha type alloy, a beta type alloy, an alpha+beta type alloy, etc., for example, and especially an alpha+beta type alloy is useful.
[0030]Also in these metal, general formula:$Fe_aM_bX_c$. (However, M is nickel or/and Co, X is Mn, Si, Ti, aluminum, and at least one sort of elements chosen from C, and a, b, and c are weight %, respectively, and) 30<=b<=40, 0<=c<=10, and a are the remainders containing inevitable impurities. The Fe-M-X system alloy shown is preferred as a material of the parts for optical connectors. The Fe-M-X system alloy expressed with the above-mentioned general formula is suitable especially as a material of the ferrule which it is easy to carry out processing with close dimensional accuracy, and equips with an optical fiber since a coefficient of linear expansion is close to the coefficient of linear expansion of an optical fiber.
[0031]
[Example]It explains still more concretely about this invention, describing hereafter the example shown in an accompanying drawing. Drawing 1 (A) shows the outline composition of one example of a method and a device which manufactures the casting mold article which has a small hole by the method of this invention. In drawing 1, the numerals 1 are split metallic molds which have the cavity 2 of a product configuration, and 3 is a wire (line a core member) which consists of a long and slender wire (line a core member) which performed surface coating or a surface treatment, or a high material of an elastic limit. The metallic mold 1 can also allocate the channel which can produce from the metallic material of copper, a copper alloy, cemented carbide, and others, and circulates cooling media and heating media, such as a fluid and a gas. On the other hand, coats, such as TiO_2, TiN, and TiC, consist of that by which surface coating was carried out, a wire material consists of the charge of spring material, a charge of high tension steel materials, a hyperelastic material, etc., or the wire 3 consists of material in which the two above-mentioned kinds of composition were put together. In order to prevent oxide film formation of a molten metal, it is preferred to arrange the whole device in a vacuum or inert gas atmospheres, such as Ar gas, or to pass inactive gas to a molten metal injection part.
[0032]When manufacturing a casting mold article, a molten metal is poured in into the cavity 2 of the metallic mold 1, and is cast, and a die temperature is below the melting point (when the charge of an amorphous alloy is used) of a molten metal. After cooling until it reaches below glass transition temperature (Tg), the metallic mold 1 is separated, and as shown in drawing 1 (B), the casting mold article 4 in the state where the wire 3 was held is taken out. Then, the casting mold article 4 which has the fine pores 5 as shown in drawing 1 (C) is obtained by drawing out the wire 3 from the obtained casting mold article.
[0033]Drawing 2 shows the example using the wire 3 with which the surface coats 6, such as TiO_2, TiN, and TiC, were covered as described above. Thus, by using the wire 3 with which the surface coat 6 was covered beforehand, in the case of wire drawing, only a wire can be drawn out because a wire and a surface coat exfoliate, and a small hole is formed. On the other hand, drawing 3 shows the example using the wire 3 which consists of a high material of elastic limits, such as a charge of spring material, a charge of high tension steel materials, and a hyperelastic material. Thus, in order that wire 3 the very thing may cause elastic deformation by using the wire 3 which consists of a high material of an elastic limit in the case of drawing, a minute crevice is formed between the casting materials 7, a wire can be drawn out and a small hole is formed.
[0034]Drawing 4 shows the outline composition of other examples of a method and a device which manufactures a casting mold article by the method of this invention. In drawing 4, the numerals 8 are the movable cylindrical guide members allocated in the cavity 2 of the metallic mold 1 enabling free projection and retreat, and the wire 3 is set in a metallic mold cavity through the feed hole of this movable cylindrical guide member 8. Since it is protected since the wire 3 of the portion covered with it by using such a cylindrical guide member 8 does not contact a molten metal, and a touch area with a casting material becomes small, the rate which the wire 3 fractures in the case of drawing decreases considerably. A small hole can be formed with sufficient accuracy, without wire 3 the very thing bending, even if a molten metal flows from a transverse direction to the wire 3 or a molten metal causes a turbulent flow within a metallic mold, since tensile load is moreover applied to the wire 3 at the longitudinal direction.
[0035]Drawing 5 shows the casting mold article 4a manufactured using the device shown in above-mentioned drawing 4, and a lower end part is cut. Although the casting mold article 4a has the narrow diameter portion 5a and the major diameter 5b, the length of the major diameter 5b can change it arbitrarily by adjusting the wire extension into the metallic mold cavity 2 of the movable cylindrical guide member 8. About the narrow diameter portion 5a, wire-wrapping processing can also be performed if needed.

[0036]Although the overall length was covered and the wire 3 with a long and slender diameter of the same was used in each above mentioned example, When a wire size uses the wire (line a core member) which is large in the direction of drawing gradually or in inclination, an inside diameter is able to fabricate the fine pores which are large gradually or in inclination to an axial direction. When the movable cylindrical guide member 8 as shown in drawing 4 is used, it becomes possible also by changing the sectional shape to form the small hole of various shape. the line set in a metallic mold cavity although said each example carried out explained manufacture of the casting mold article which has a breakthrough -- a core -- the casting mold article which has a non-breakthrough can also be manufactured by adjusting the height of a member.
[0037]Hereafter, some examples which checked the effect of this invention concretely are shown.
It cast using the device shown in drawing 1 (A) using the wire which coated the wire made from SUS of 1phi0.1 mm of examples with TiO_2 10 micrometers in thickness by PVD. Casting was performed by the vacuum atmosphere of $1.33x10^{-2}$Pa using the alloy which has the presentation of Zr_{55}aluminum$_{10}$nickel$_5$$Cu_{30}$ ingoted beforehand. The metallic mold whose size of a cavity is phi2.5x10.5mm was used. The casting mold article was taken out after casting, the above-mentioned wire was drawn out at the rate of 1.7 mm/s, and the small hole was made to form. The drawing load at this time was 294-N[/mm] ^{2}. When the formed fine pores were checked under the microscope, fine pores with the circular sectional shape of the wire made from SUS were formed.
[0038]It cast in the same method using the same metallic mold as Example 1 using the wire in which a 5-micrometer oxide film was formed in the wire surface by oxidizing the wire made from Ti of 2phi0.1 mm of examples. Drawing load is 98-N[/mm] ^{2}, and is ******. When the formed fine pores were checked under the microscope, fine pores with the circular sectional shape of the wire made from Ti were formed.
[0039]Same casting was performed using the wire in which a 4-micrometer oxide film was formed in the wire surface made from a 45nickel-55 Ti-system superelastic alloy of 3phi0.1 mm of examples. Drawing load is 785-N [/mm] ^{2}, and is ******. When the formed fine pores were checked under the microscope, fine pores with the circular sectional shape of the wire were formed.
[0040]
[Effect of the Invention]as mentioned above, the line which is used for casting of the casting mold article which has a small hole according to the method and device of this invention -- a core -- the difficulty of the drawing after casting of a member and various problems resulting from endurance are reduced, and the casting mold article which has a small hole by low cost can be manufactured with productivity sufficient for a short time. Even if it is an amorphous alloy cast which has a slit, as a result, shape predetermined with an easy process again, A fabricating operation can be carried out in close dimensional accuracy and surface quality, and the cheap amorphous alloy cast which has the small hole excellent in endurance, intensity, shock resistance, etc., especially the parts for optical connectors (a ferrule, a capillary, etc.) are provided.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an outline fragmentary sectional view showing one example of the manufacturing process of the casting mold article of this invention.
[Drawing 2]the line which coated the surface coat -- a core -- it is an outline fragmentary sectional view showing the example using a member.
[Drawing 3]the line produced from the material which is easy to carry out elastic deformation -- a core -- it is an outline fragmentary sectional view showing the example using a member.
[Drawing 4]It is an outline fragmentary sectional view showing another example of the manufacturing installation of the casting mold article of this invention.
[Drawing 5]It is an outline sectional view showing the cast manufactured using the device shown in drawing 4.
[Drawing 6]A capillary part and a flange are the outline fragmentary sectional views showing the integral-type ferrule for optical connectors.
[Drawing 7]A capillary and a flange are the outline fragmentary sectional views showing the ferrule for optical connectors of a separated type.
[Description of Notations]
1 Metallic mold
2 Cavity
3 a line -- a core -- a member (wire)
4 Casting mold article
5 Fine pores
6 Surface coat
7 Casting material
8 Cylindrical guide member

[Translation done.]

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2.**** shows the word which can not be translated.
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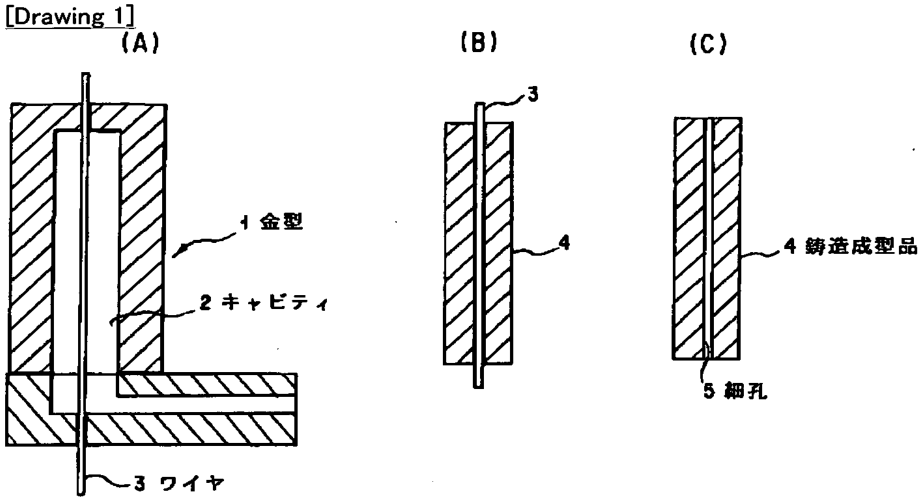
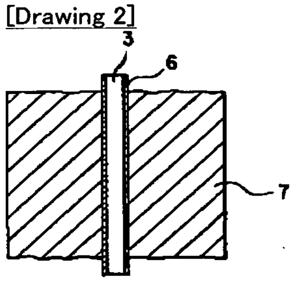
DRAWINGS

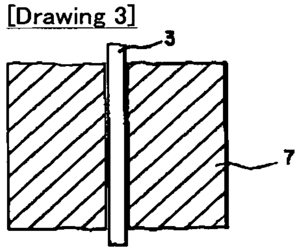
[Drawing 1]



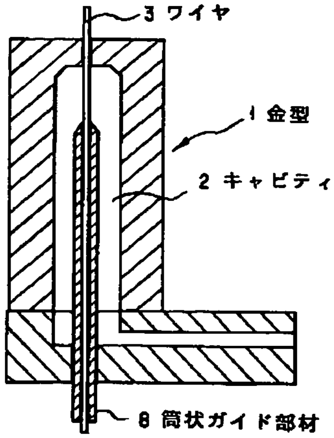
[Drawing 2]



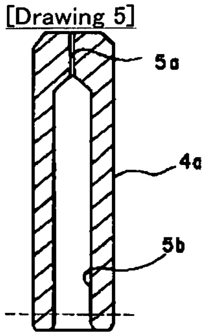
[Drawing 3]



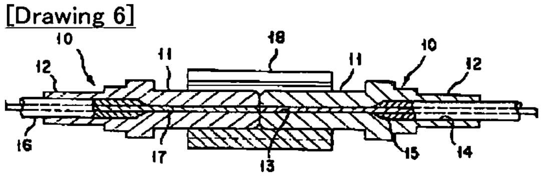
[Drawing 4]



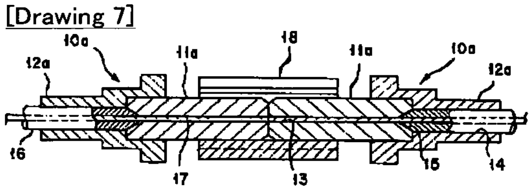
[Drawing 5]



[Drawing 6]



[Drawing 7]



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Ｂ２２Ｄ　29/00		Ｂ２２Ｄ　29/00	Ｆ
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(71)出願人　000006828
ワイケイケイ株式会社
東京都千代田区神田和泉町１番地

(72)発明者　長浜　秀信
宮城県仙台市泉区泉中央３－38－５

(72)発明者　山口　正志
宮城県仙台市太白区泉崎１－16－23

(72)発明者　佐藤　正紀
千葉県船橋市新高根２－11－７

(74)代理人　100097135
弁理士　▲吉▼田　繁喜

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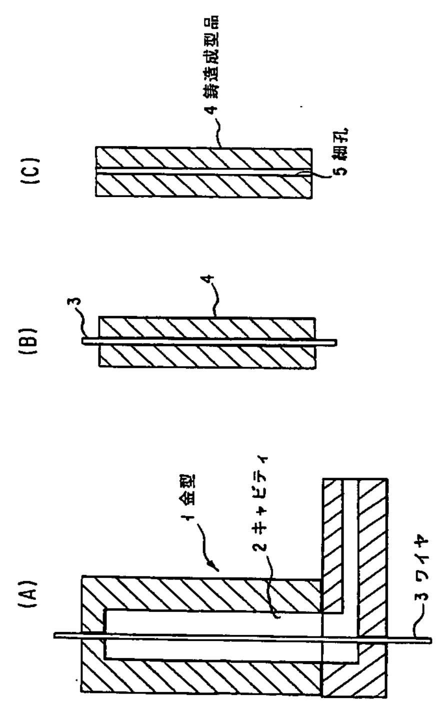
(54)【発明の名称】　細穴を有する鋳造成型品の製造方法及び装置

(57)【要約】

【課題】　鋳造後の線状中子部材の引き抜きの困難性や耐久性に起因する問題を軽減し、短時間に生産性よく低コストで、細穴を有する鋳造成型品を製造できる方法及び装置を提供する。

【解決手段】　所望の断面形状のワイヤ（線状中子部材）３が予めセットされた金型１のキャビティ２内に金属溶湯を鋳込む際、該ワイヤとして表面被覆又は表面処理を施したワイヤを用い、鋳造後に鋳造材からワイヤを引き抜く際、表面被覆又は表面処理により形成された皮膜が部分的に又は全体的に剥離してワイヤのみが引き抜けるようにすることにより、ワイヤの断面形状の細孔５が形成された鋳造成型品４を製造できる。上記ワイヤとして弾性限の高い材料からなるワイヤを用いることにより、鋳造後に鋳造材から上記ワイヤを引き抜く際、ワイヤが引き抜き方向に弾性変形することによりワイヤ径が細くなり、ワイヤが鋳造材内部から引き抜けるようにすることもできる。



【特許請求の範囲】

【請求項１】　所望の断面形状を持つ線状中子部材がセットされた金型のキャビティ内に金属溶湯を鋳込み、上記線状中子部材の断面形状を持つ細穴を形成した鋳造成型品を製造する方法において、上記線状中子部材が表面被覆又は表面処理を施した線状中子部材であり、鋳造後に鋳造材から線状中子部材を引き抜くことで上記線状中子部材の断面形状を持った細穴を形成することを特徴とする、細穴を有する鋳造成型品の製造方法。

【請求項２】　鋳造後に鋳造材から線状中子部材を引き抜く際、上記表面被覆又は表面処理により形成された皮膜の一部分もしくは全ての部分が線状中子部材表面から剥離することにより、線状中子部材が鋳造材内部から引き抜けるようにしたことを特徴とする請求項１に記載の方法。

【請求項３】　前記線状中子部材の表面被覆又は表面処理により形成された皮膜が、線状中子部材を構成している元素を含む酸化膜、窒化膜又は炭化膜であることを特徴とする請求項１又は２に記載の方法。

【請求項４】　前記線状中子部材がＴｉ系合金からなることを特徴とする請求項１乃至３のいずれか一項に記載の方法。

【請求項５】　前記線状中子部材の表面被覆又は表面処理により形成された皮膜の厚さが、０．５～１００μｍであることを特徴とする請求項１乃至４のいずれか一項に記載の方法。

【請求項６】　所望の断面形状を持つ線状中子部材がセットされた金型のキャビティ内に金属溶湯を鋳込み、上記線状中子部材の断面形状を持つ細穴を形成した鋳造成型品を製造する方法において、鋳造後に鋳造材から線状中子部材を引く抜く際、線状中子部材が引き抜き方向に弾性変形することにより線状中子部材の径が細くなり、線状中子部材が鋳造材内部から引き抜けるようにしたことを特徴とする、細穴を有する鋳造成型品の製造方法。

【請求項７】　前記線状中子部材がＮｉ－Ｔｉ系超弾性合金からなることを特徴とする請求項１乃至６のいずれか一項に記載の方法。

【請求項８】　前記線状中子部材の太さがϕ０．０２５～ϕ１ｍｍであることを特徴とする請求項１乃至７のいずれか一項に記載の方法。

【請求項９】　前記線状中子部材を金型内にセットする際、線状中子部材の長手方向に１９６０Ｎ／ｍｍ^{2}以下の引張荷重を加え、この状態で金型のキャビティ内に金属溶湯を鋳込むことを特徴とする請求項１乃至８のいずれか一項に記載の方法。

【請求項１０】　前記鋳造材が、少なくとも体積率５０％以上の非晶質相を含む合金であることを特徴とする請求項１乃至９のいずれか一項に記載の方法。

【請求項１１】　前記非晶質合金が、下記一般式（１）～（６）のいずれか１つで示される組成を有する実質的に非晶質の合金であることを特徴とする請求項１０に記載の方法。

一般式（１）：$M^1{}_a M^2{}_b Ln_c M^3{}_d M^4{}_e M^5{}_f$

但し、M^1はＺｒ及びＨｆから選ばれる１種又は２種の元素、M^2はＮｉ、Ｃｕ、Ｆｅ、Ｃｏ、Ｍｎ、Ｎｂ、Ｔｉ、Ｖ、Ｃｒ、Ｚｎ、Ａｌ及びＧａよりなる群から選ばれる少なくとも１種の元素、ＬｎはＹ、Ｌａ、Ｃｅ、Ｎｄ、Ｓｍ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｙｂ及びMm（希土類元素の集合体であるミッシュメタル）よりなる群から選ばれる少なくとも１種の元素、M^3はＢｅ、Ｂ、Ｃ、Ｎ及びＯよりなる群から選ばれる少なくとも１種の元素、M^4はＴａ、Ｗ及びＭｏよりなる群から選ばれる少なくとも１種の元素、M^5はＡｕ、Ｐｔ、Ｐｄ及びＡｇよりなる群から選ばれる少なくとも１種の元素、ａ、ｂ、ｃ、ｄ、ｅ及びｆはそれぞれ原子％で、$25 \leqq a \leqq 85$、$15 \leqq b \leqq 75$、$0 \leqq c \leqq 30$、$0 \leqq d \leqq 30$、$0 \leqq e \leqq 15$、$0 \leqq f \leqq 15$である。

一般式（２）：$Al_{100-g-h-i} Ln_g M^6{}_h M^3{}_i$

但し、ＬｎはＹ、Ｌａ、Ｃｅ、Ｎｄ、Ｓｍ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｙｂ及びMmよりなる群から選ばれる少なくとも１種の元素、M^6はＴｉ、Ｖ、Ｃｒ、Ｍｎ、Ｆｅ、Ｃｏ、Ｎｉ、Ｃｕ、Ｚｒ、Ｎｂ、Ｍｏ、Ｈｆ、Ｔａ及びWよりなる群から選ばれる少なくとも１種の元素、M^3はＢｅ、Ｂ、Ｃ、Ｎ及びＯよりなる群から選ばれる少なくとも１種の元素、ｇ、ｈ及びｉはそれぞれ原子％で、$30 \leqq g \leqq 90$、$0 < h \leqq 55$、$0 \leqq i \leqq 10$である。

一般式（３）：$Mg_{100-p} M^7{}_p$

但し、M^7はＣｕ、Ｎｉ、Ｓｎ及びＺｎよりなる群から選ばれる少なくとも１種の元素、ｐは原子％で$5 \leqq p \leqq 60$である。

一般式（４）：$Mg_{100-q-r} M^7{}_q M^8{}_r$

但し、M^7はＣｕ、Ｎｉ、Ｓｎ及びＺｎよりなる群から選ばれる少なくとも１種の元素、M^8はＡｌ、Ｓｉ及びＣａよりなる群から選ばれる少なくとも１種の元素、ｑ及びｒはそれぞれ原子％で、$1 \leqq q \leqq 35$、$1 \leqq r \leqq 25$である。

一般式（５）：$Mg_{100-q-s} M^7{}_q M^9{}_s$

但し、M^7はＣｕ、Ｎｉ、Ｓｎ及びＺｎよりなる群から選ばれる少なくとも１種の元素、M^9はＹ、Ｌａ、Ｃｅ、Ｎｄ、Ｓｍ及びMmよりなる群から選ばれる少なくとも１種の元素、ｑ及びｓはそれぞれ原子％で、$1 \leqq q \leqq 35$、$3 \leqq s \leqq 25$である。

一般式（６）：$Mg_{100-q-r-s} M^7{}_q M^8{}_r M^9{}_s$

但し、M^7はＣｕ、Ｎｉ、Ｓｎ及びＺｎよりなる群から選ばれる少なくとも１種の元素、M^8はＡｌ、Ｓｉ及びＣａよりなる群から選ばれる少なくとも１種の元素、M^9はＹ、Ｌａ、Ｃｅ、Ｎｄ、Ｓｍ及びMmよりなる群から選ばれる少なくとも１種の元素、ｑ、ｒ及びｓはそれぞれ原子％で、$1 \leqq q \leqq 35$、$1 \leqq r \leqq 25$、$3 \leqq s \leqq$